

CHAPTER II  
GEOLOGY OF THE AREA

The geological setting of the area under investigation is described in the following paragraphs. The various lithological units exposed in the area around Malvan have been described, by referring to the previous work of Foote (1876), Kelkar (1956), Krishnan (1964), Pascoe (1968), Narayanamurthy, et al. (1978), Viswanathaiah, (1979), Chandrasekhar Gowda (1981) and Jayaprakash et al. (1987). 7

#### REGIONAL GEOLOGY

The area under investigation form a coastal tract of the southern Sindhudurg district, which is about 10 km. in width. This coastal tract is marked by rocky bays, which are capped with laterites and by the development of discontinuous sandy beaches in between.

In the northern and southern parts of the area, the Kaladgis are exposed in the areas around Achra and Malvan. The Kaladgis even expose a little offshore, forming small islands. The Deccan basalts unconformably overlies the Kaladgis and are exposed in the eastern part of the coastal tract near Kurkavla area.

The regional geological setting of the area has been shown in Fig. 2.1.

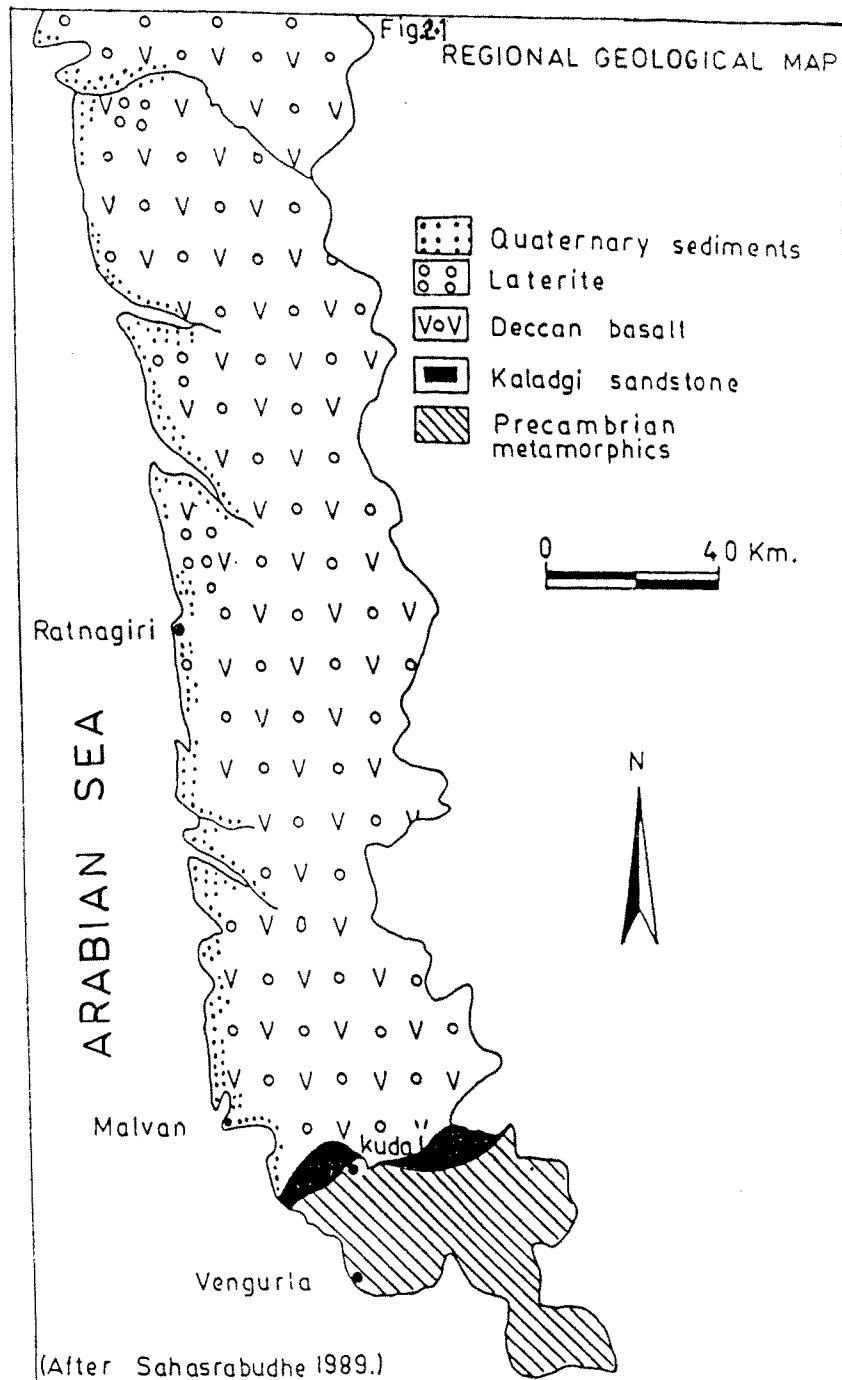
The geological succession studied by Kelkar (1956) in the Sindhudurg district, Maharashtra is presented in Table 2.1.

From the field characters, the geological succession in the area under investigation has been worked out and can be given as,

Unconsolidated	sediments	Quaternary
Consolidated		
- - - - - Unconformity - - - - -		
Deccan Basalts		Upper Cretaceous to Miocene
- - - - - Unconformity - - - - -		
Shale Sandstone and quartzite	Kaladgi Group	Middle to Late Proterozoic
- - - - - Unconformity - - - - -		
Granite basement		Archaean

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The geology of the area has been presented in Fig. 2.2 and the field and lithological characters of the rocks exposed



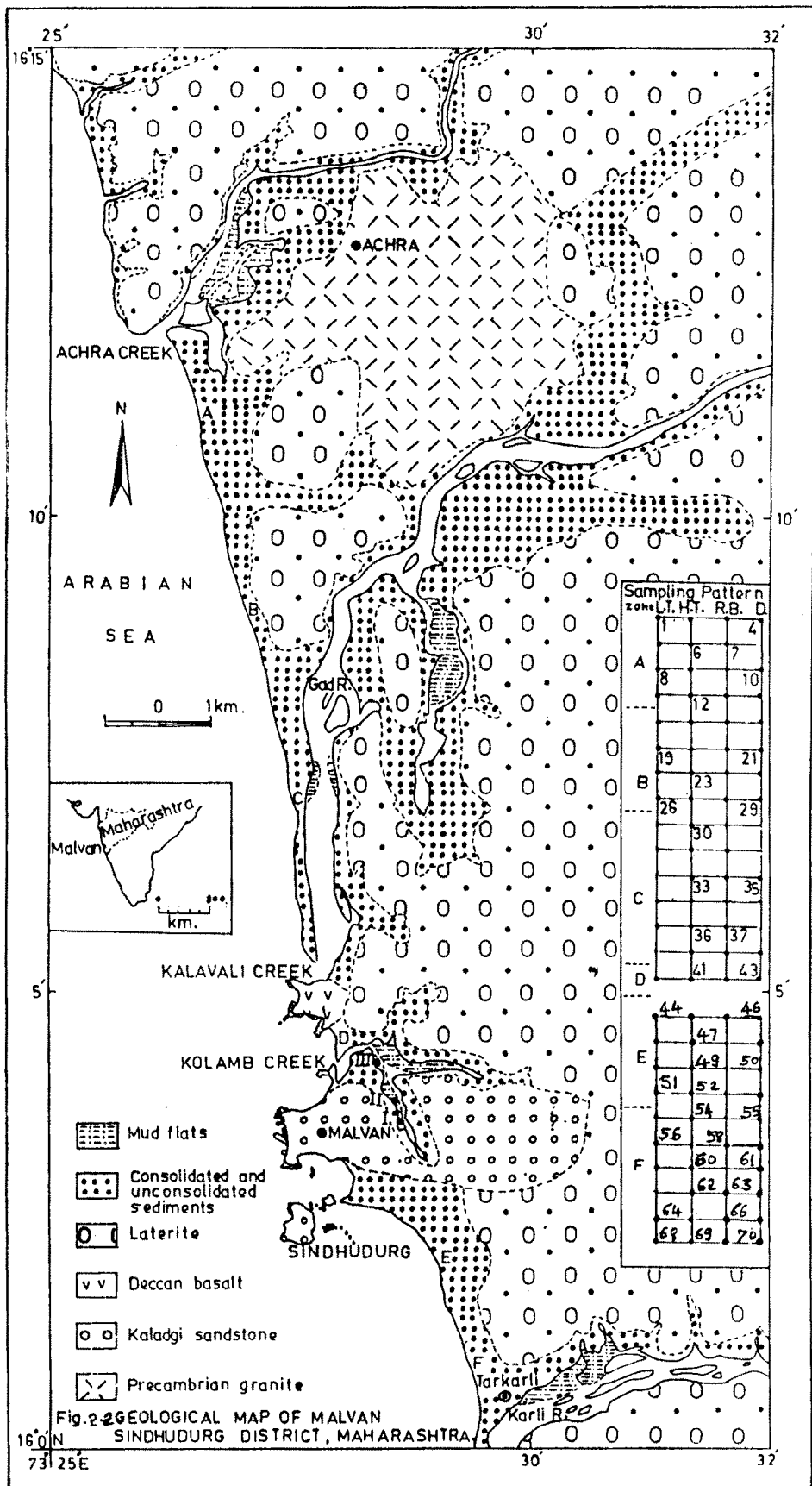


Table 2.1 : Geological Succession from Sindhudurg District  
(after Kelkar 1956)

Unconsolidated and consolidated beach sands and Alluvium	
Laterites	
----- Unconformity -----	
Deccan volcanics	Upper Cretaceous to Miocene
----- Unconformity -----	
Sandstone, Conglomerate, Micaceous sandstone, Quartzite	Kaladgi Series
----- Unconformity -----	
Basic intrusives - Pegmatites and quartz veins, acid intrusives Granite gneisses and granite, mica schist, garnet mica schist, haematite quartzites and quartzites	Archaeans
----- Unconformity -----	
Basement not seen	

in the area have been detailed in the following paragraphs;

#### THE ARCHAEOAN GRANITIC ROCKS

The central part of the southern Indian Peninsula is composed of the oldest rock units. It is a complex of the Greenstones, Granulites, Granites and granitic rocks. The evolution of the Complex and the formation of the stable Archaean Nuclei have been worked out by numerous workers. Geological Society of India has brought out a Special publication on 'Precambrian of South India' (1983), that relates to the field characters, lithological associations, structural characters, tectonic evolution, geochemical aspects and geochronology of this Archaean Basement Complex.

Another publication of the Geological Society of India (1990) has dealt with the evolutionary history of the Archaean Greenstone belts of South India. These are considered mainly as mafic and ultramafic intrusions within the gneisses of varying dimensions (Radhakrishna, 1983).

This Archaean Complex has experienced four major phases of orogenic activities, represented by the granites, termed in the Indian stratigraphy, as; the Champion Gneiss, Peninsular Gneiss, Charnockites and the Clospet Granites. These granitic

rocks can be distinguished by the varying and their distinct lithological characters and contain in them, the inclusions of the early mafic and ultramafic rocks.

Most of the published literature on the Archaean Basement Complex relates mainly to the areas from the Karnataka, Kerala and Tamil Nadu States. However, there is hardly any published literature on the Precambrians exposed in the area selected for the present study.

In the area under investigation are exposed mainly the granites and granitic rocks. Few patches of granitic rocks occur in the eastern part of the study area near Rathiwada. It is fine grained, light in colour. The exposure of granites are also noticed in some parts of Kankavali and Mangaon. It shows gneissic to granitic texture and consists predominantly of quartz, orthoclase, microcline, biotite and hornblende. It is found to be traversed by aplitic and quartz veins, which are about 2 to 5 cm. in width.

#### THE KALADGI GROUP

The Archaean rocks represented by the granites and granitic rocks, mafic and ultramafic rocks are found to be unconformably overlain by relatively less metamorphosed orthoquartzite-carbonates suite of rocks, which have been



generally assigned an age of Middle to Late Proterozoic.

These rocks are represented by the rock formations belonging to the Cuddapah Supergroup, Vindhyan Supergroup, Kaladgi Group, the Kurnool Group, etc. Detailed lithological, sedimentological and evolutionary aspects of these Proterozoic basins have been brought out in the Special publication of the Geological Society of India (1987).

From the regional geological study, it has been found that the rocks belonging to the Kaladgi and Badami Groups have been exposed mainly in the States of Karnataka and Andhra Pradesh; of which the Kaladgi basin lies to the west of Bhima basin and covers an area of approximately of about 8,300 sq.kms., with a total thickness of about 4,500 m.

Lithostratigraphic classification of the Kaladgi Group has been presented earlier by Viswanathain (1977) (Table No. 2.2) wherein he has distinguished the Badami Group from the Kaladgi Group of rocks, with the presence of an unconformity.

Jayprakash, et al. (1987), however, have elevated the status of the Kaladgi Group and termed it as the Kaladgi Supergroup, comprising mainly the lower Bagalkot Group and the upper Badami Group.

Table No. 2.2 : Classification of the Kaladgis, based on  
Lithostratigraphy by Viswanathiah (1977)

Group	Formation	Members	
Badami	Unconformity		
		Mudhol	Machkandi Argillite Laksanhatti Dolomite Niralkeri Breccia Vajramatti Quartzarenite
		Transitional Facies Contact	Yadhalli Argillite Petlur Limestone
	Kaladgi	Lokapur	Jalikatti Argillite Chikshellikeri Limestone Chitrabhanukot Dolomite
			Transitional Facies Contact
		Bagalkot	Biligi Quartzarenite Salagundi Conglomerate
		Unconformity	
		Metasedimentary and Intrusive rock	Basement

The lithological succession worked out by them is represented by the basal arkose or conglomerate, followed by mature arenites, passing into argillites and cherts; suggesting a gradual increase in depth and condition of quiescence.

The main Kaladgi Group is exposed in the Karnataka State and the rocks of its western extremities are exposed in the Kolhapur district and in parts of the coastal tract of Sindhudurg district.

In the area under study there are exposed mainly the sandstones and quartzites belonging to the Kaladgi Supergroup. The sandstones and quartzites, in turn, are overlain by shales.

The sandstones and quartzites are exposed in the area around Achra and Malvan. Sandstones strike NW - SE, dipping due SW by an amount of about 60°. Sandstones are medium to fine grained and are well cemented. Sandstones comprise predominantly quartz and are generally pink or reddish pink in colour. At few places, such as; at Malvan the sandstone has been found to be lateritised.

The sandstones, in turn, gradually grade into shales, which are reddish pink to white in colour. They are thinly bedded, friable and fragile. The exposures of shales have been located in the area around Achra which are of smaller dimensions.

## DECCAN TRAP FLOOD BASALT

Deccan basalts which cover an area of about 500,000 km<sup>2</sup>, are exposed on the west central part of Peninsular India. The earlier view that the Deccan basalts were erupted in Late Cretaceous to Early Tertiary times (Washington, 1922) has been confirmed by radiometric dating (Duncan and Pyle, 1988a), which gives an age of about 60 - 65 Ma.

Geological map of the Deccan Trap lava sequence has been published by Beane, et al. (1986) and Devey and Lightfoot (1986) on the basis of geochemistry. The area covered by these authors extends for about 350 km in N - S direction from 19°, 20' N (Malsej Ghat) to the southern end of the outcrop at 15°, 45' N (Belgaum) and is about 100 km. wide extending inland from west coast. Recently, Subbarao <sup>et al.</sup> and Hooper (1988) have combined previous studies and published the geological map of the southwestern Deccan outcrop, which shows that the stratigraphically older lavas (Lonavala and Kalsubai Supergroups) crop out in the northern Bombay - Nasik area, whilst the younger flows (Wai Subgroup) are exposed south of 18° N. The map includes data from the E - W reconnaissance traces of Mitchell and Cox (1988) that extends approximately 300 km east of the Western Ghats ridge between

latitudes 17° N and 18° N. Recently, a detailed geological map of the Deccan basalt, particularly south of 18° N is published by Mitchell and Widdowson (1991), presenting new sample data alongwith a synthesis of the earlier work.

The classification by Mitchell and Widdowson (Table 2.3) has proved successful in identifying the chemical types as, the Poladpur, Ambenali, Mahebaleshwar and Panhala Formations, which comprise the upper part of the Deccan lava sequence, termed as the Wai Subgroup by Beane, et,al.(1986). None of the magma types characterising the Bushe and lower Formations (Table 2.3) defined by Beane, et,al. (1986) have been identified in the region south of latitude 18° N (Mitchell and Widdowson, 1991).

Variations in geochemical parameters with respect to topography have been used to define the Formations and have been discussed by <sup>9</sup>Dercy and Lightfoot (1986). It is the initial  $Sr^{86}/Sr^{87}$  ratio that displays sharp breaks at the formation boundaries and therefore this parameter is considered as the principal criterion in defining Formation boundaries. *Dercy?*

The boundaries as defined by the other trace element criteria are commonly transitional. For instance, Ba content

begins to increase in the Ambenali Fm., about 300 m below the upper boundary, defined by Sr - isotope ratio. Though, sharp breaks in Zr/Nb, Ba/y, Sr - isotope ratios and Sr concentrations have been encountered at the contact of the Mahabaleshwar - Ambenali Formations, these breaks however, do not occur at the same elevation.

Generally, trace element data alone are effective in identifying Formations on a regional scale. Ambiguities in ascribing the flow to the respective Formation only occur near the Formation boundaries. The only unambiguous criterion for distinguishing between the Bushe, Poladpur, Ambenali and Mahabaleshwar Formations is their initial Sr - isotope ratio (Mitchell and Widdowson, 1991).

The Deccan basalts from the present area of investigation belong to Ambenali Formation of Wai Subgroup (Mitchell and Widdowson, 1991). The Mahabaleshwar Formation lies on the lower part of outlying ridges of the Western Ghats in the area around Kolhapur.

Table 2.3 : Different Formations within the basalt pile  
(after Beane et al. (1986)).

Subgroup	Formation
Wai	Panhala
	Mahabaleshwar
	Ambenali
	Poladpur
Lonavala	Bushe
	Khandala
Kalsubai	Bhimashankar
	Thakurvadi
	Neral
	Igatpuri

#### LATERITES

Laterites, in general, exhibit a porous, pitted, earthy appearance with red, yellow, brown or grey mottled colours, invariably with limonitic crust. Laterite caps all the rock formations from Precambrians to Quaternary sediments. The laterite profiles have been classified into four different

types, namely; mature, immature, reworked and induced, depending on their lithological variations, by Sahasrabudhe (1989), while studying coastal laterites of the Maharashtra State.

Presence of two separate horizons of laterites, resting on the Deccan basalts and also resting on the superimposed Quaternary sediments in one bore hole near Ratnagiri has revealed the possibility of recognising two independent episodes of lateritisation in the Late Eocene and Neogene periods (Sahasrabudhe, op. cit.).

Laterites associated with higher marine shelves are indicative of structure and tectonic disturbances and also eustatic changes in sea levels, which have helped in understanding structure, tectonics and evolution of the West Coast of Maharashtra (Sahasrabudhe, op. cit.).

The laterites are the weathered products of the basalt and sandstone in the present area of investigation. In the northern part in the area around Achra, Hindli, Sarjekot; the laterites are derived from basalt and are brown in colour. Base of the laterite profiles is marked by yellowish brown coloured lithomarge (Plate II , Photo No. 1 ). However, it is observed that in the southern part of the area the laterite is



derived from the basalt as can be seen around Malvan as well as from the sandstone i.e. the Sindhudurg Fort. It is dark brown to brick red in colour. The laterites derived from the sandstone exhibit the presence of sand grains.

#### QUATERNARY SEDIMENTS

Along the coast between Achra and Karli creek area, there is an extensive deposit of carbonate sediments, which overlie the Deccan basalts. However, at and around Malvan, these sediments overlie the Kaladgi sandstone. These coastal sediments are referred to in the literature as, 'Raised beaches' (Oldham, 1885), 'Calcareous Grit' (Mathur and Naidu, 1932), 'Littoral concrete' (Pascoe, 1965), 'beach sandstones' (Blanford, 1872) and 'beach rock' (Setty and Wagle, 1972).

Field characters and sedimentological studies of the Quaternary sediments in the coastal region between Alibag and Srivardhan, district Raigarh, Maharashtra have been dealt with by Sawant and Sukhtankar (1985).

Grain size measures have been used by Sukhtankar and Pandian (1988) to construct sediment - trend matrix and thereby to infer the major transport directions along the coast. Trends in grain size measures of the Quaternary

sediments of the Vengurla coast has also been studied with reference to beach morphology and tectonic evolution by Sukhtankar (1986).

The coastal Quaternary sediments mainly in the intertidal zone from the area bounded between Agashi creek in the north and Bassein creek in the south; district Thane, Maharashtra, have been investigated for their sedimentological characters by Sukhtankar and Pandian (1988).

The Quaternary sediments in the present area of investigation are exposed along the coast between Achra and Karli creeks. These sediments are either unconsolidated or little consolidated and are usually found to be exposed in vertical sections with an average elevation of about 1 m. They contain molluscan shell fragments in varying proportions and exhibit thin, horizontal laminations. The unconsolidated sediments are usually consolidated at the base. A very good section is observed at Kolamb creek (Plate II , Photo No. 2).

At the same place, the base of the section consists of consolidated sediments. These are similar in composition as those of the unconsolidated sediments. They exhibit a good development of stratification. At the base of the exposed section, these are relatively coarse grained, gradually becoming finer and finer towards the top of the section.